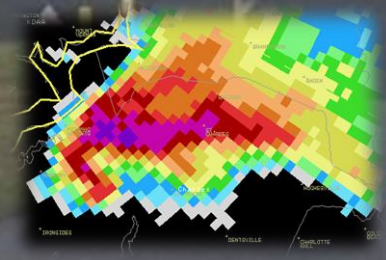
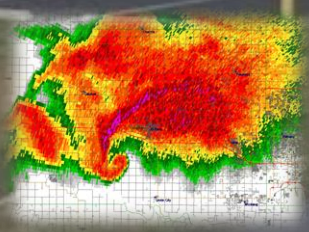


Severe Storms & Tornadoes in the Mid-Atlantic

*What is our history?
&
What is the worst that could
happen?*



Greg Schoor
Severe Weather Program Leader
NWS Baltimore/Washington

NWS/EM/Media Conference – 10/16/14

TOPICS

Thunderstorm/tornado structure

Boxology: Issuing Warnings

Severe Thunderstorms & the wind threat – *taking it seriously*

Our tornado history & climatology

(E)F5s – how can tornadoes get that strong?

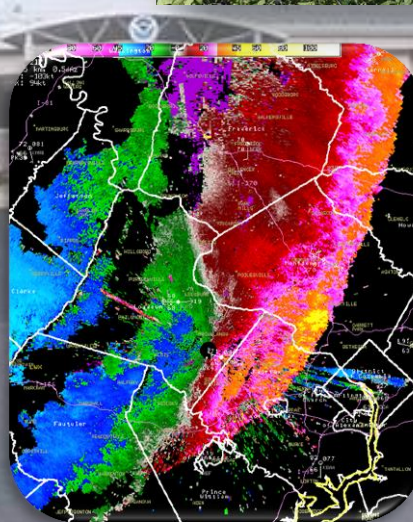
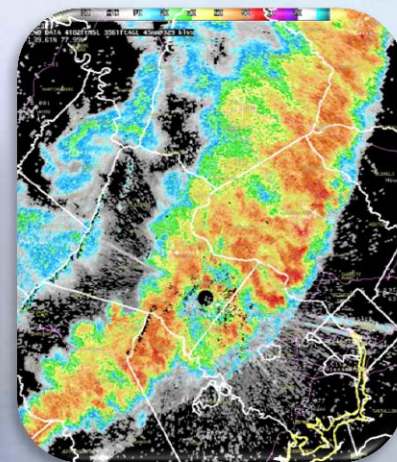
Tornado Topography

Tornado damage tracks

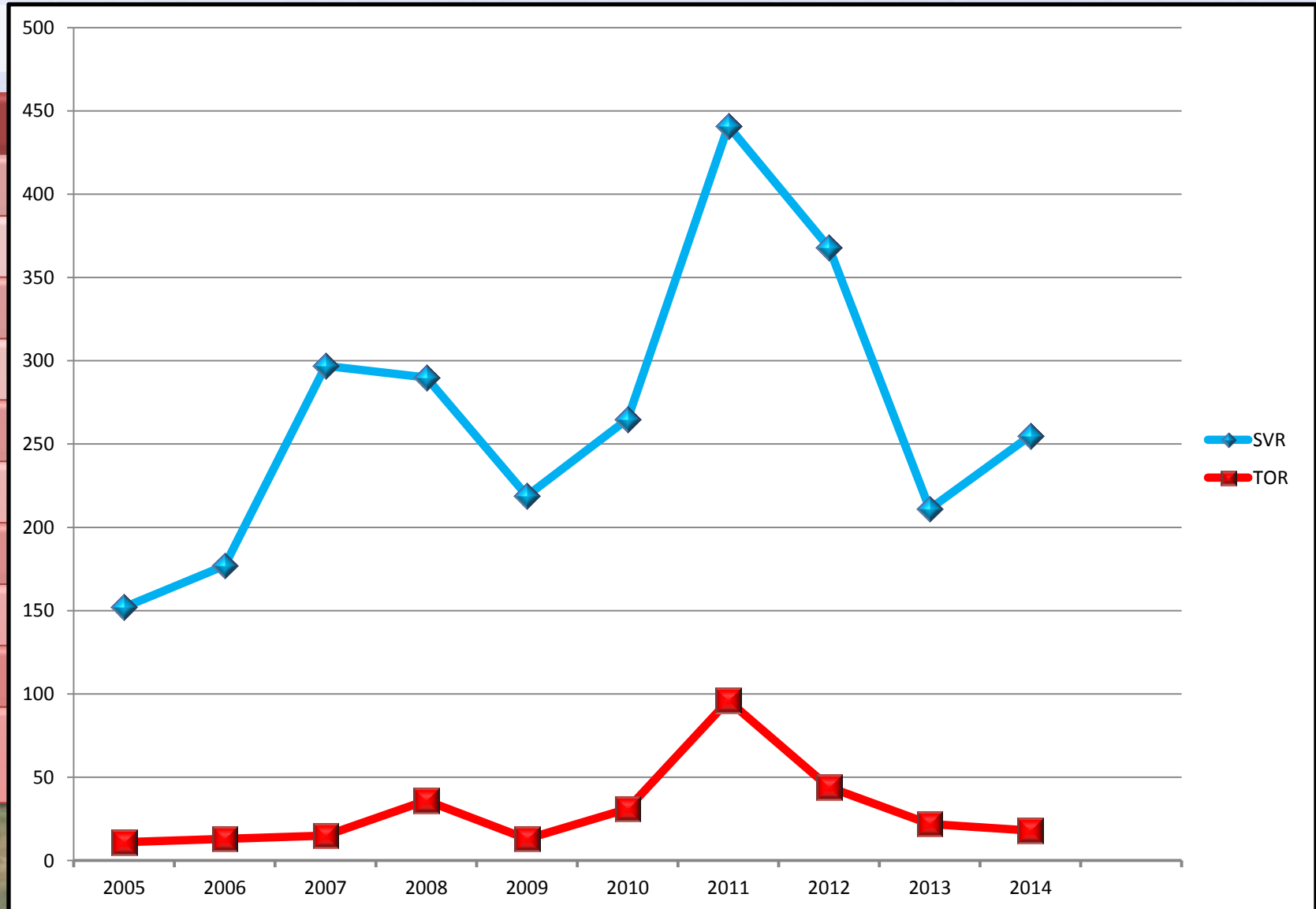
What worst tornado situation...here

Wrap-up

The biggest tornado – ever.

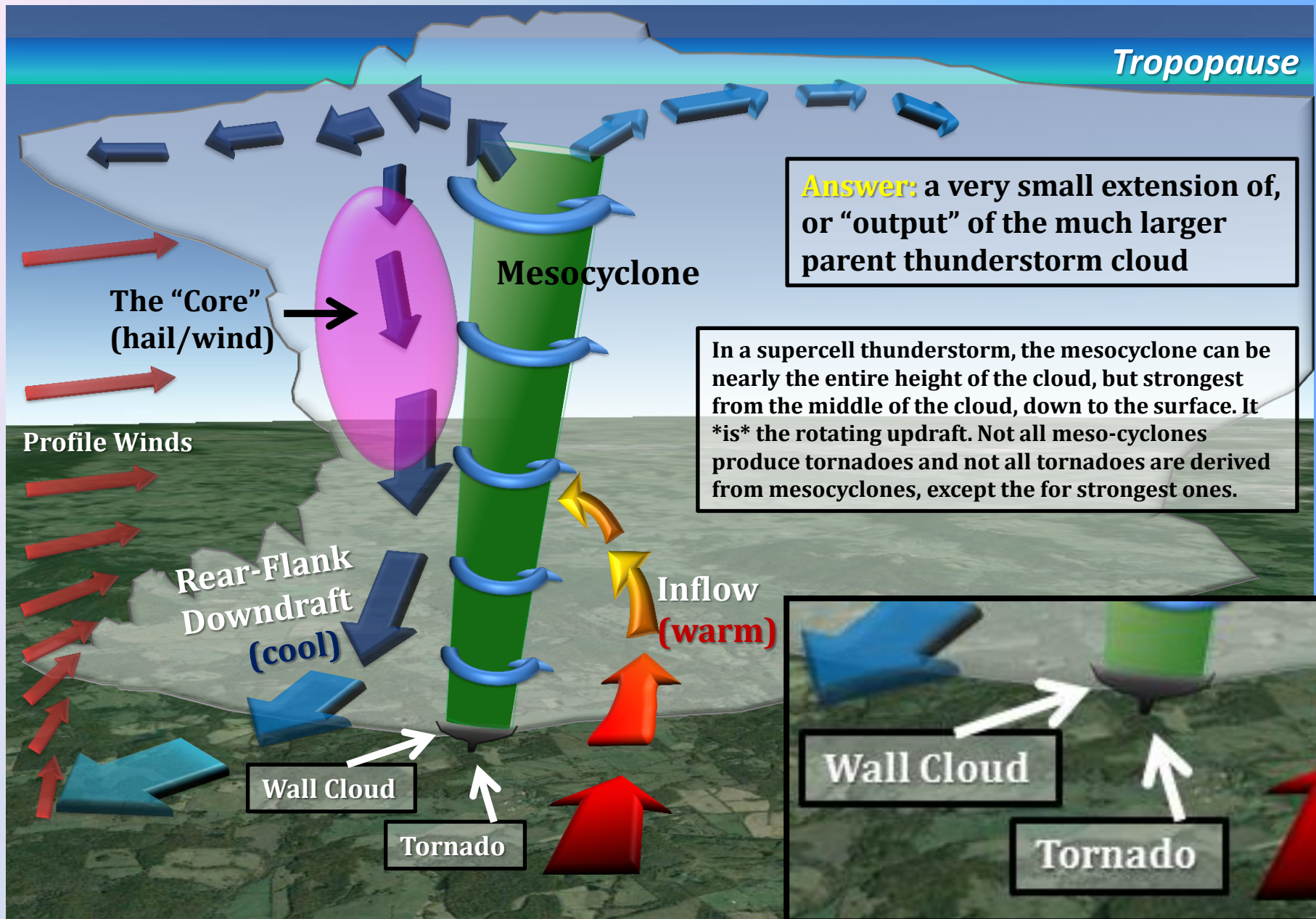


How many *severe warnings* in a typical year?

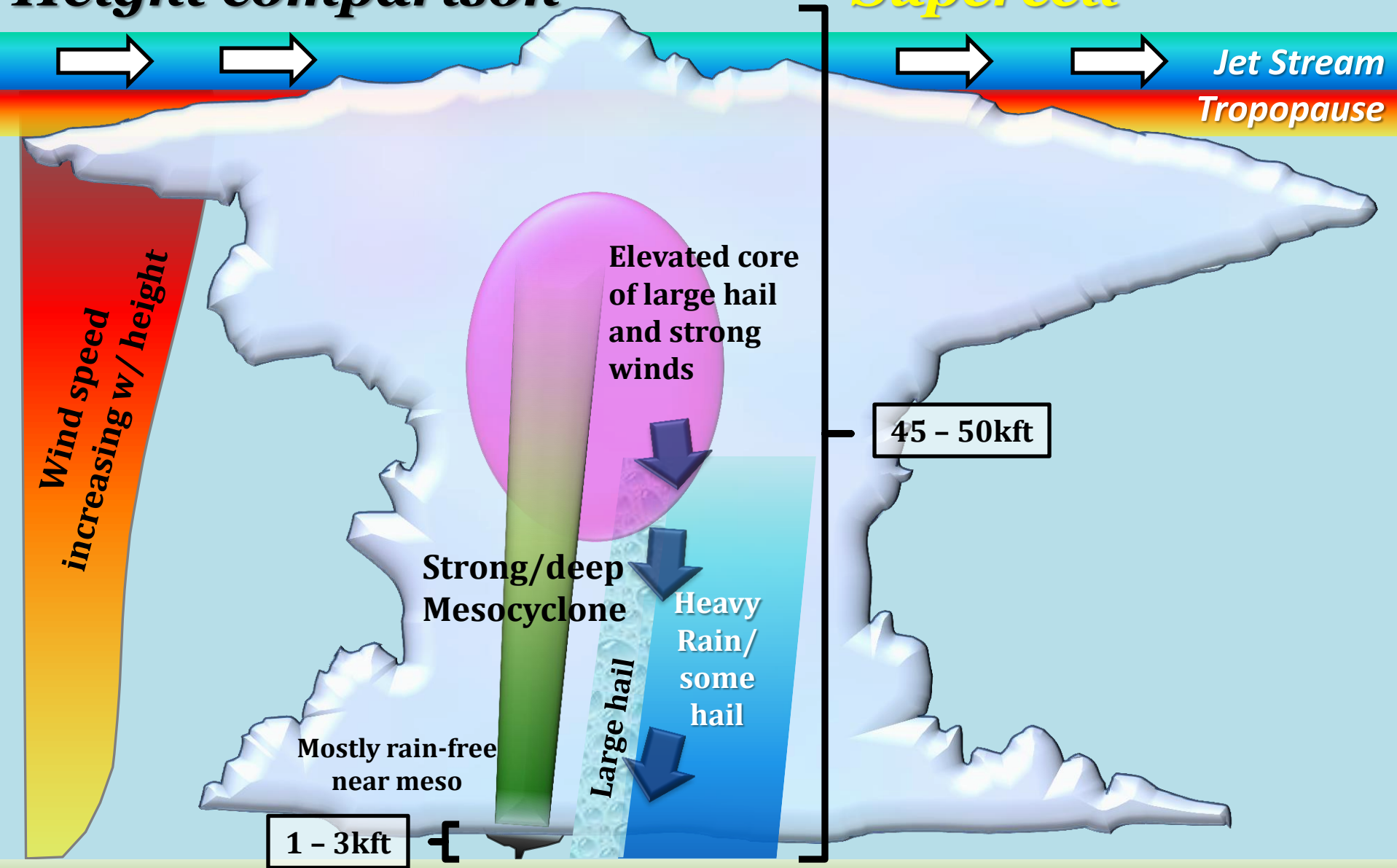


TOR = Tornado Warning

What is a tornado (*size-wise*)?

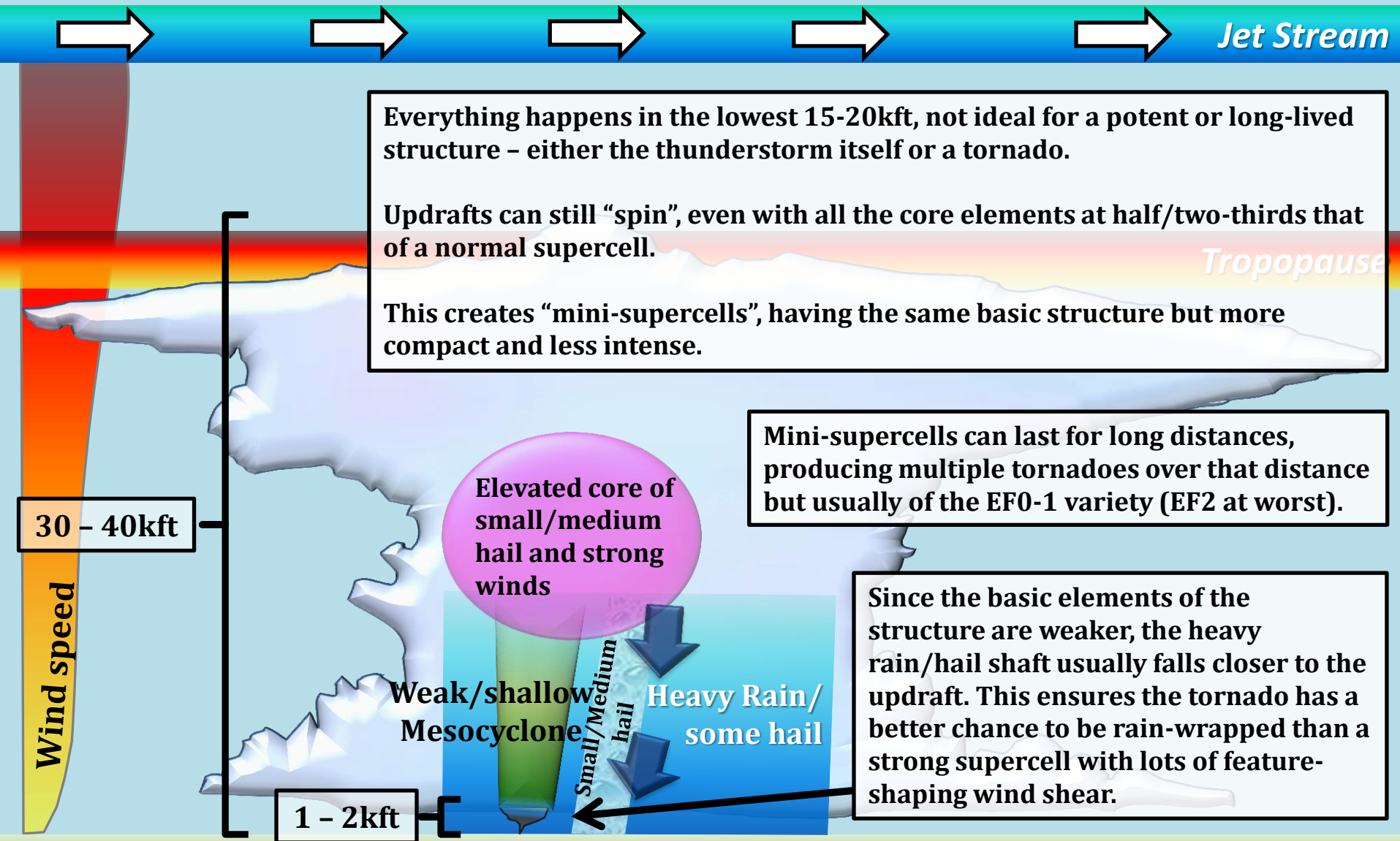


Height comparison



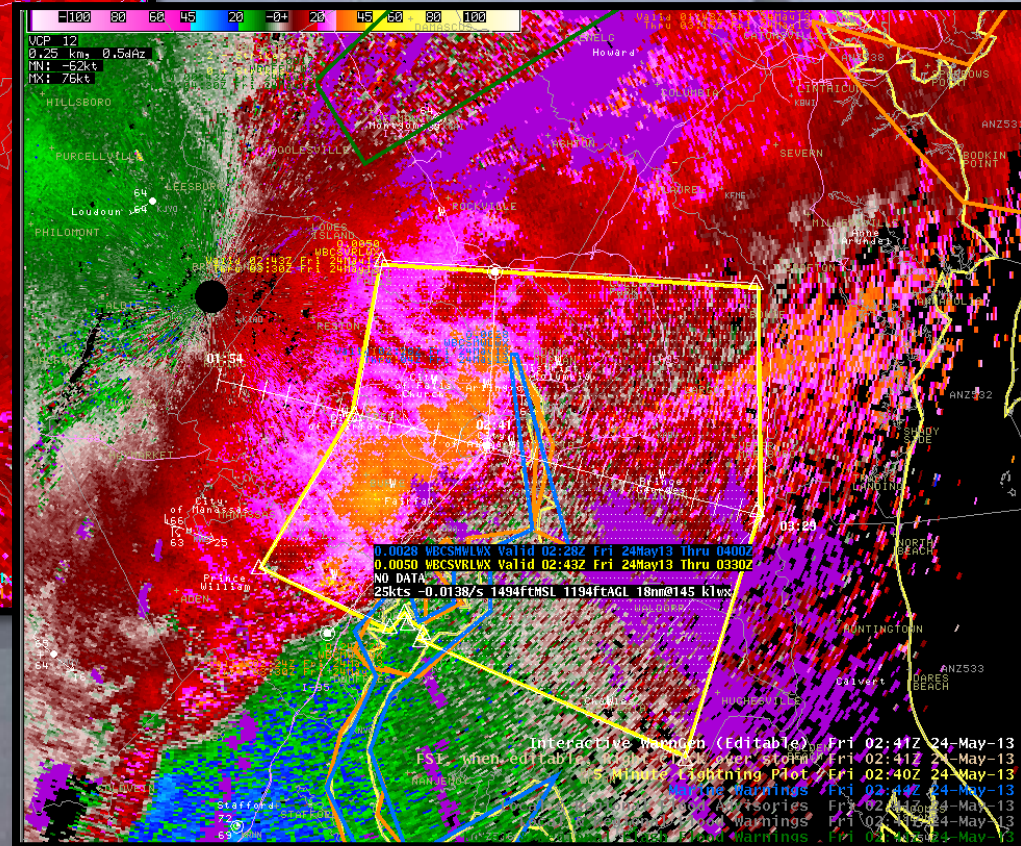
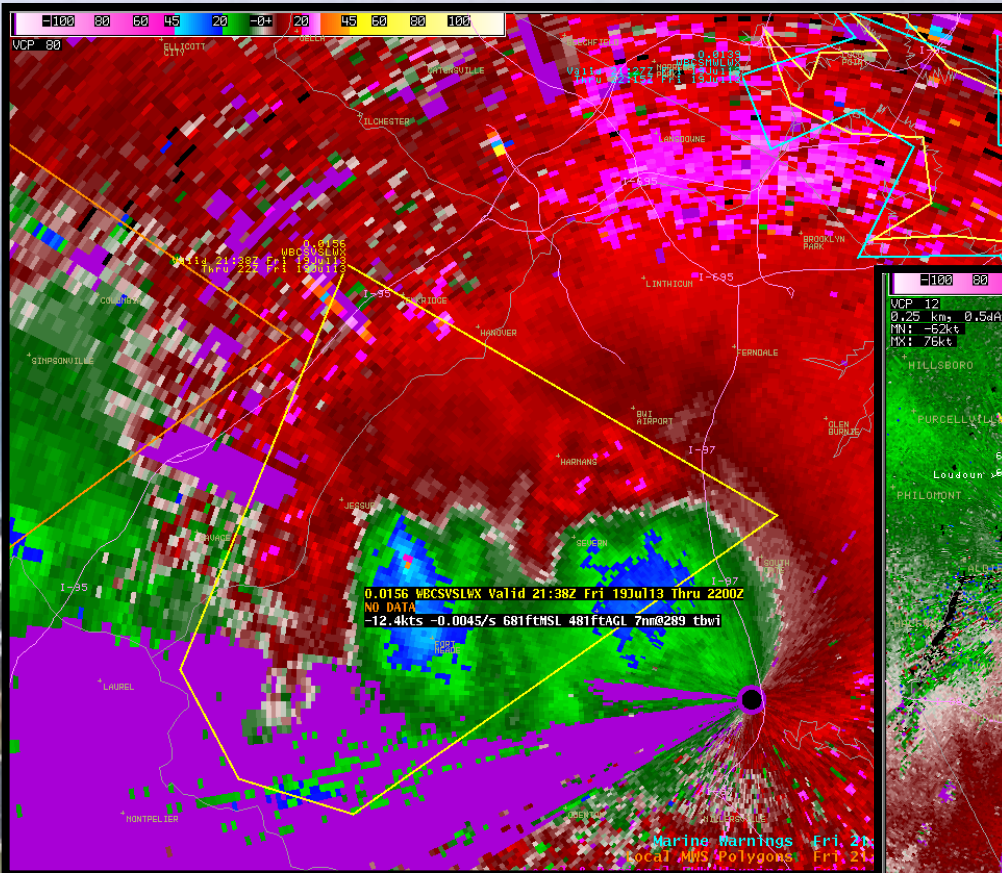
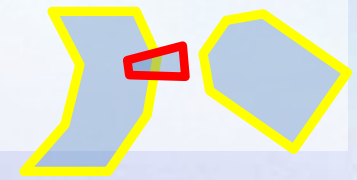
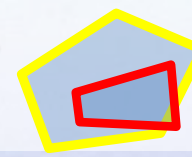
Height comparison

Typical Mid-Atlantic



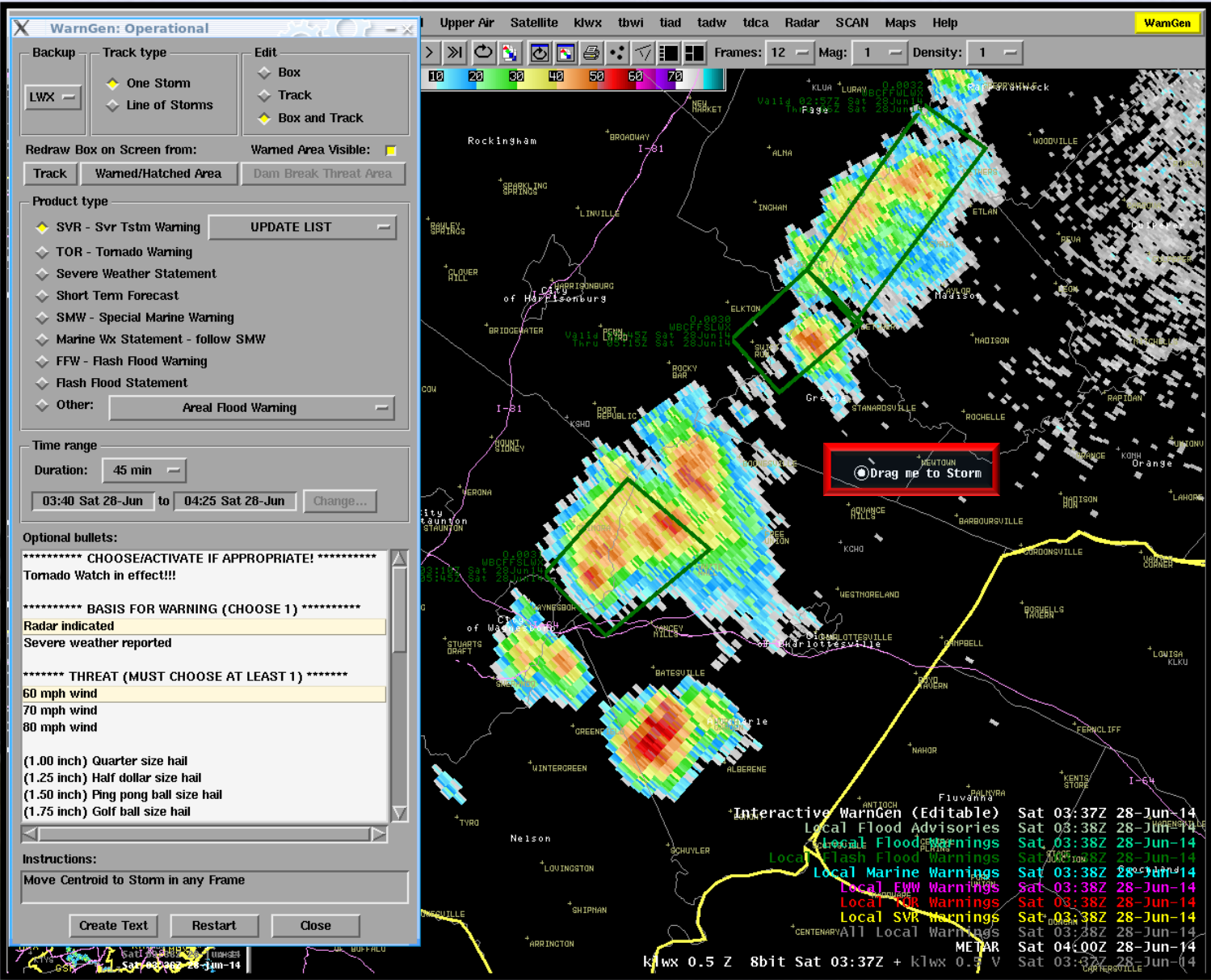
True, the Mid-Atlantic has plenty of low-level moisture (Spring/Summer) and an occasional low-level jet max (especially along/E of I-95) but all the ingredients just typically aren't as strong as the other areas.

BOXOLOGY



WarnGen

Warning Generation



File View Options Tools Volume

WarnGen: Operational

Backup Track type

LWX

One Storm
Line of Storms

Redraw Box on Screen from:

Track Warned/Hatched Area

Product type

SVR - Svr Tstm Warning
TOR - Tornado Warning
Severe Weather Statement
Short Term Forecast
SMW - Special Marine Warning
Marine Wx Statement - follow SMW
FFW - Flash Flood Warning
Flash Flood Statement
Other: Areal Flood W

Time range

Duration: 60 min

03:48 Sat 28-Jun to 04:48 Sat 28-Jun

Optional bullets:

***** CHOOSE/ACTIVATE IF APPROPRIATE *****
Tornado Watch in effect!!!

***** BASIS FOR WARNING (CHOOSE ONE) *****
Radar indicated
Severe weather reported

THREAT (MUST CHOOSE AT LEAST ONE)

60 mph wind
70 mph wind
80 mph wind

(1.00 inch) Quarter size hail
(1.25 inch) Half dollar size hail
(1.50 inch) Ping pong ball size hail
(1.75 inch) Golf ball size hail

Instructions:

Adjust Centroid in any Frame
Adjust box around Warning Area

Create Text Restart

Status: 03:48 Sat 28-Jun-14

File Edit Options Version Tools Scripts Products Help

AFOS Browser Load History WMO Search Enter Editor Accum Update Obs Clear

AFOS Cmd: WMO TTAai CCCC: AWIPS ID:

WUUS51 KLWX 190353
SVRLWX
DCCC001-MDC017-033-VAC013-059-153-179-510-190445-
/O.NEW.KLWX.SV.W.0083.140619T0353Z-140619T0445Z/

BULLETIN - EAS ACTIVATION REQUESTED
SEVERE THUNDERSTORM WARNING
NATIONAL WEATHER SERVICE BALTIMORE MD/WASHINGTON DC
1153 PM EDT WED JUN 18 2014

THE NATIONAL WEATHER SERVICE IN STERLING VIRGINIA HAS ISSUED A

* SEVERE THUNDERSTORM WARNING FOR...
THE SOUTHERN DISTRICT OF COLUMBIA...
SOUTHEASTERN ARLINGTON COUNTY IN NORTHERN VIRGINIA...
SOUTHWESTERN PRINCE GEORGES COUNTY IN CENTRAL MARYLAND...
CITY OF ALEXANDRIA IN NORTHERN VIRGINIA...
NORTHERN CHARLES COUNTY IN SOUTHERN MARYLAND...
SOUTHEASTERN FAIRFAX COUNTY IN NORTHERN VIRGINIA...
SOUTHEASTERN PRINCE WILLIAM COUNTY IN NORTHERN VIRGINIA...
NORTHERN STAFFORD COUNTY IN NORTHERN VIRGINIA...

* UNTIL 1245 AM EDT

* AT 1151 PM EDT...SEVERE THUNDERSTORMS WERE DETECTED ALONG A LINE
EXTENDING FROM DUKES TO DUE CREEK AND WERE MOVING EAST AT 25 MPH

THIS LINE OF STORMS IS CAPABLE OF PRODUCING HAIL UP TO THE SIZE OF
QUARTERS AND DAMAGING WINDS IN EXCESS OF 60 MPH.

* LOCATIONS IMPACTED INCLUDE...
WOODBIDGE...
NEWINGTON...
LORTON...
FRANCONIA...
SPRINGFIELD...
THE I395 AND I495 INTERCHANGE...
LINCOLNIA...
FORT BELVOIR...
HUNTINGTON...
ALEXANDRIA...

PRECAUTIONARY/PREPAREDNESS ACTIONS...

THIS IS A DANGEROUS LINE OF STORMS. IF YOU ARE IN ITS PATH...MOVE
INDOORS TO A STURDY BUILDING AND STAY AWAY FROM WINDOWS. WHEN IT IS
SAFE TO DO SO...REPORT SEVERE WEATHER TO LOCAL LAW ENFORCEMENT OR TO
THE NATIONAL WEATHER SERVICE.

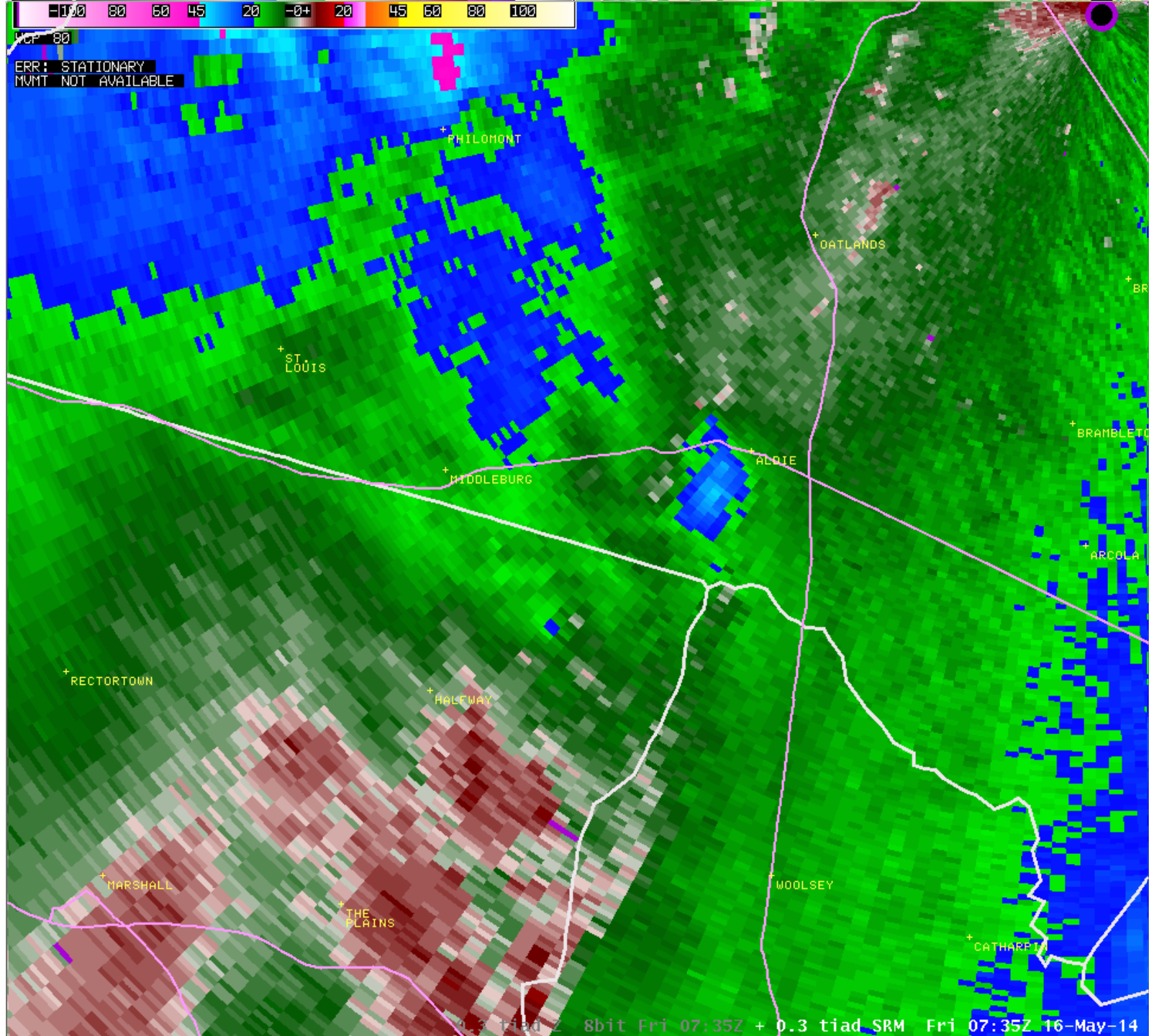
THIS LINE OF STORMS IS PRODUCING FREQUENT CLOUD TO GROUND LIGHTNING.
IF YOU CAN HEAR THUNDER...YOU ARE CLOSE ENOUGH TO BE STRUCK BY
LIGHTNING. MOVE INDOORS IMMEDIATELY.

&&

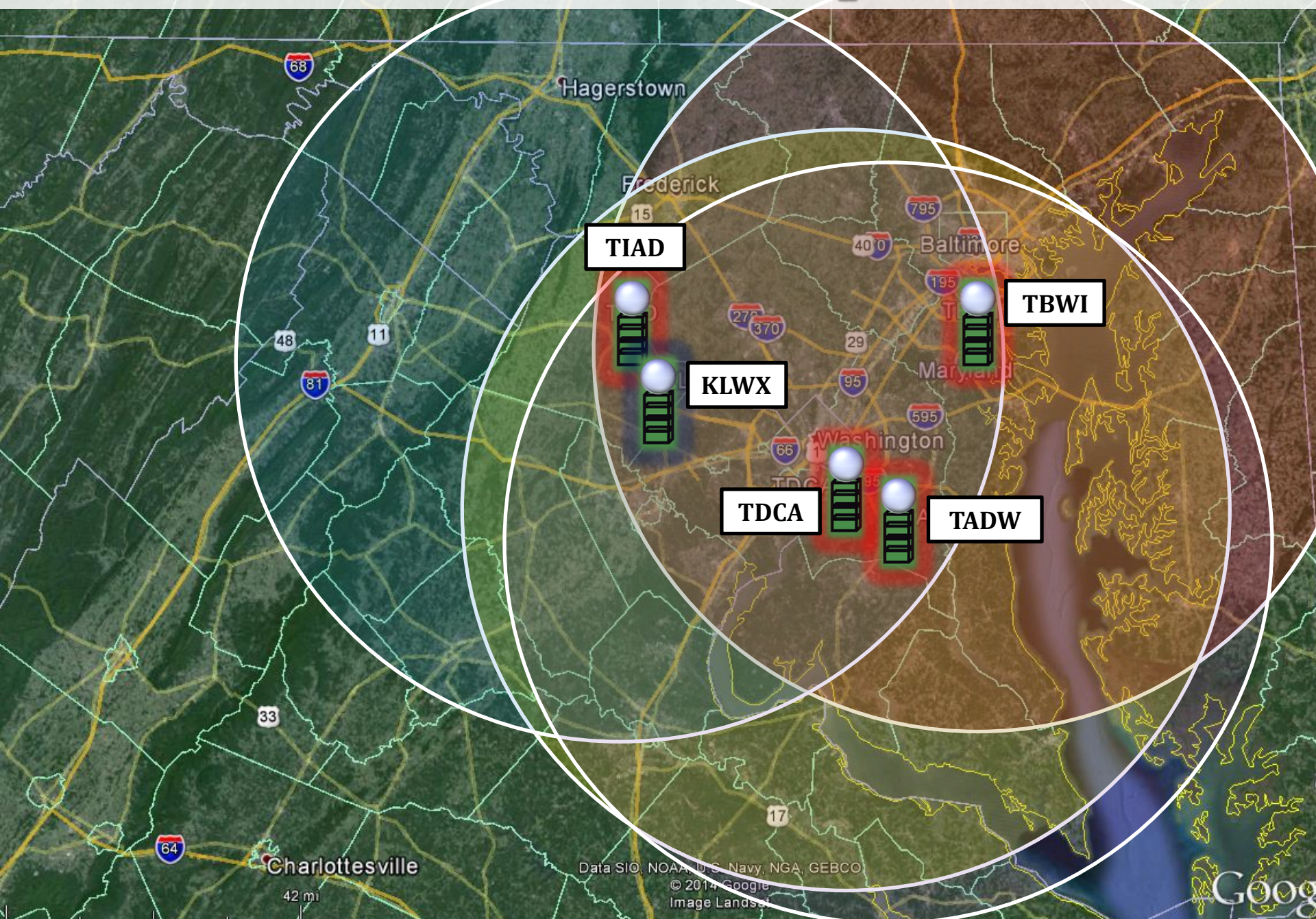
LAT...LON 3863 7699 3859 7719 3861 7719 3863 7723
3858 7724 3854 7750 3880 7734 3886 7686
TIME...MOT...LOC 0353Z 258DEG 24KT 3874 7727 3864 7733

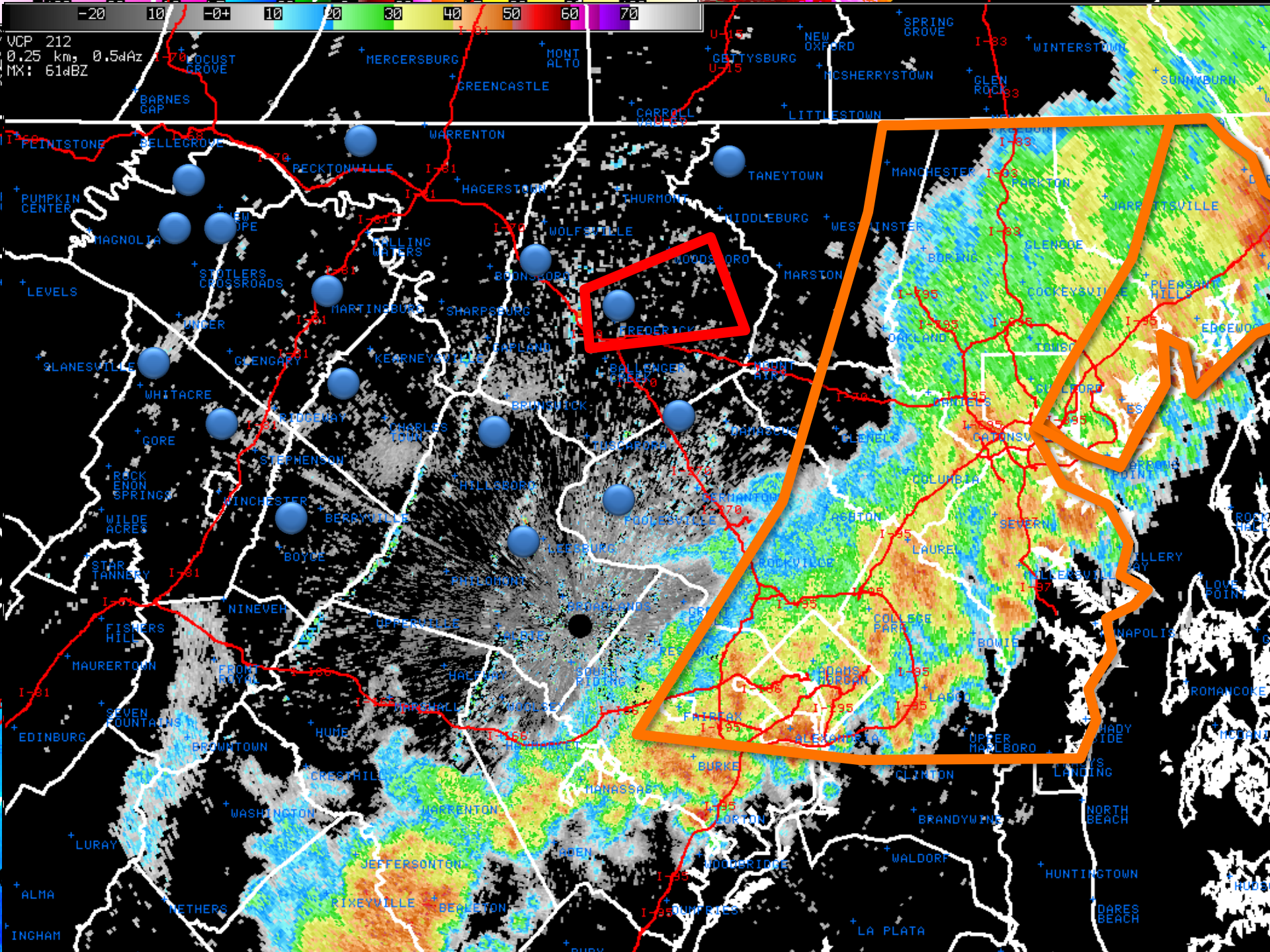


T D W R S

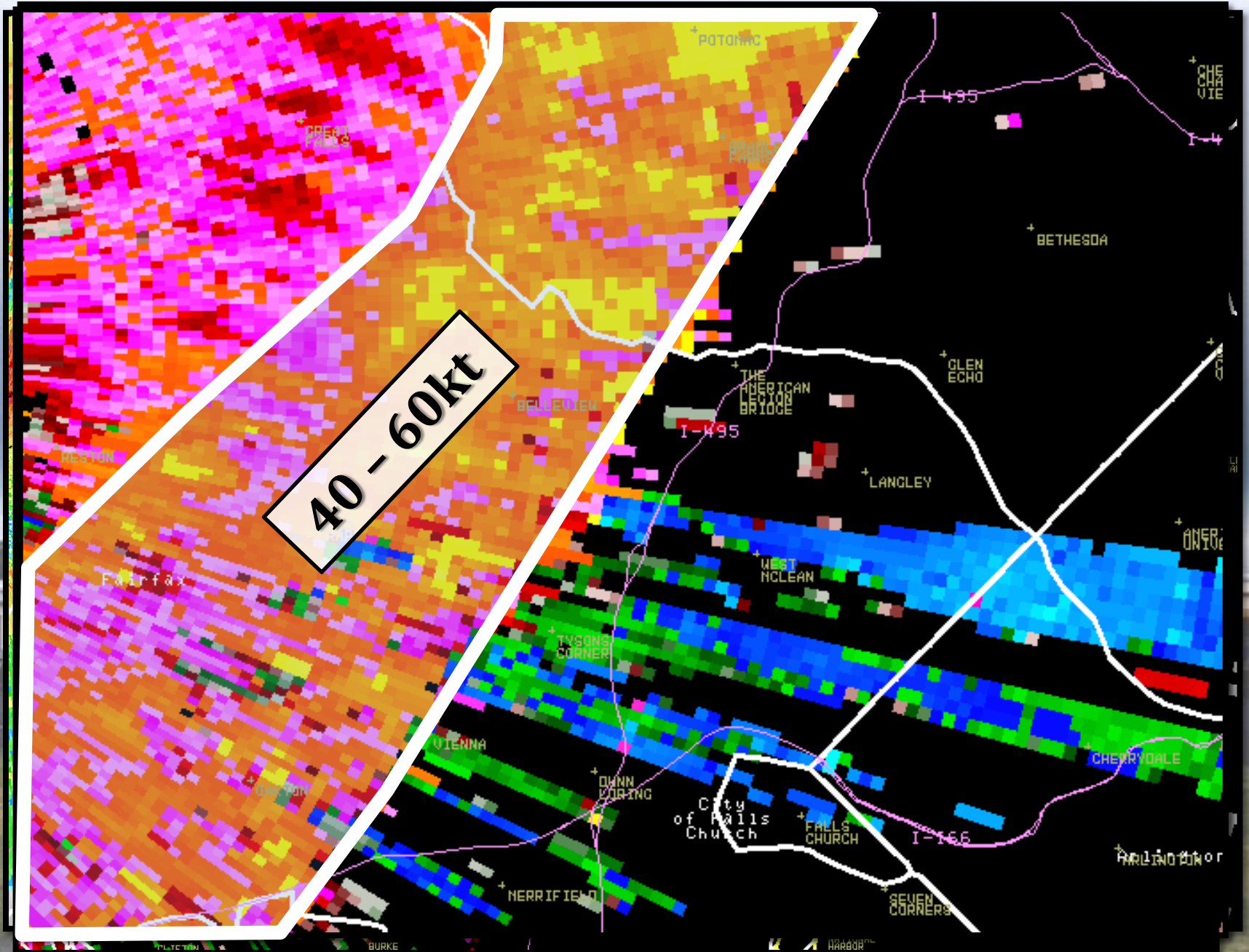


We're Surrounded...by radars





Severe Winds – *the danger of leading edge gust fronts*



Severe Winds – *the danger of leading edge gust fronts*

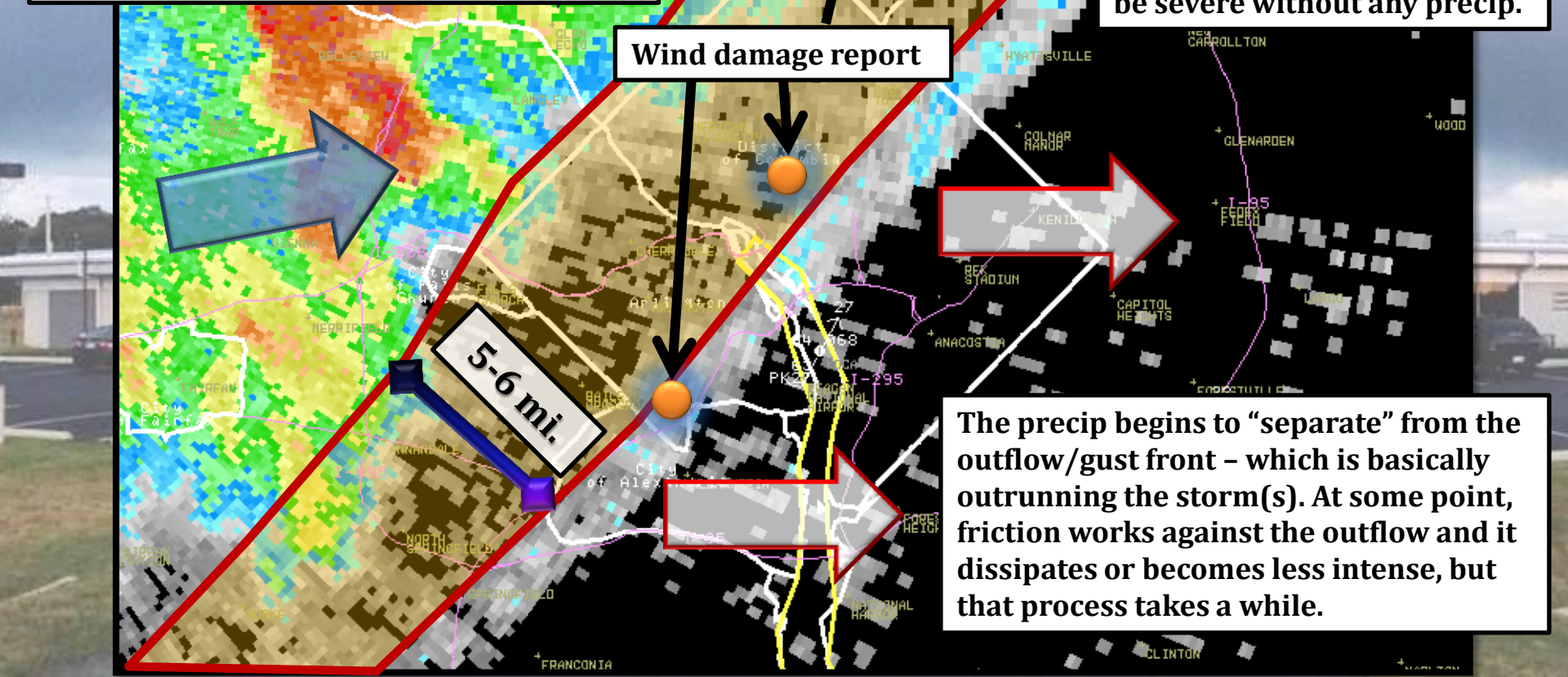
With the speed of the gust front (40-50 mph itself – or more), you will be receiving severe winds several minutes before the first drop of rain or being under most “ominous” part of the incoming roll/shelf cloud

Winds along and just behind the fast-moving outflow can be severe without any precip.

Wind damage report

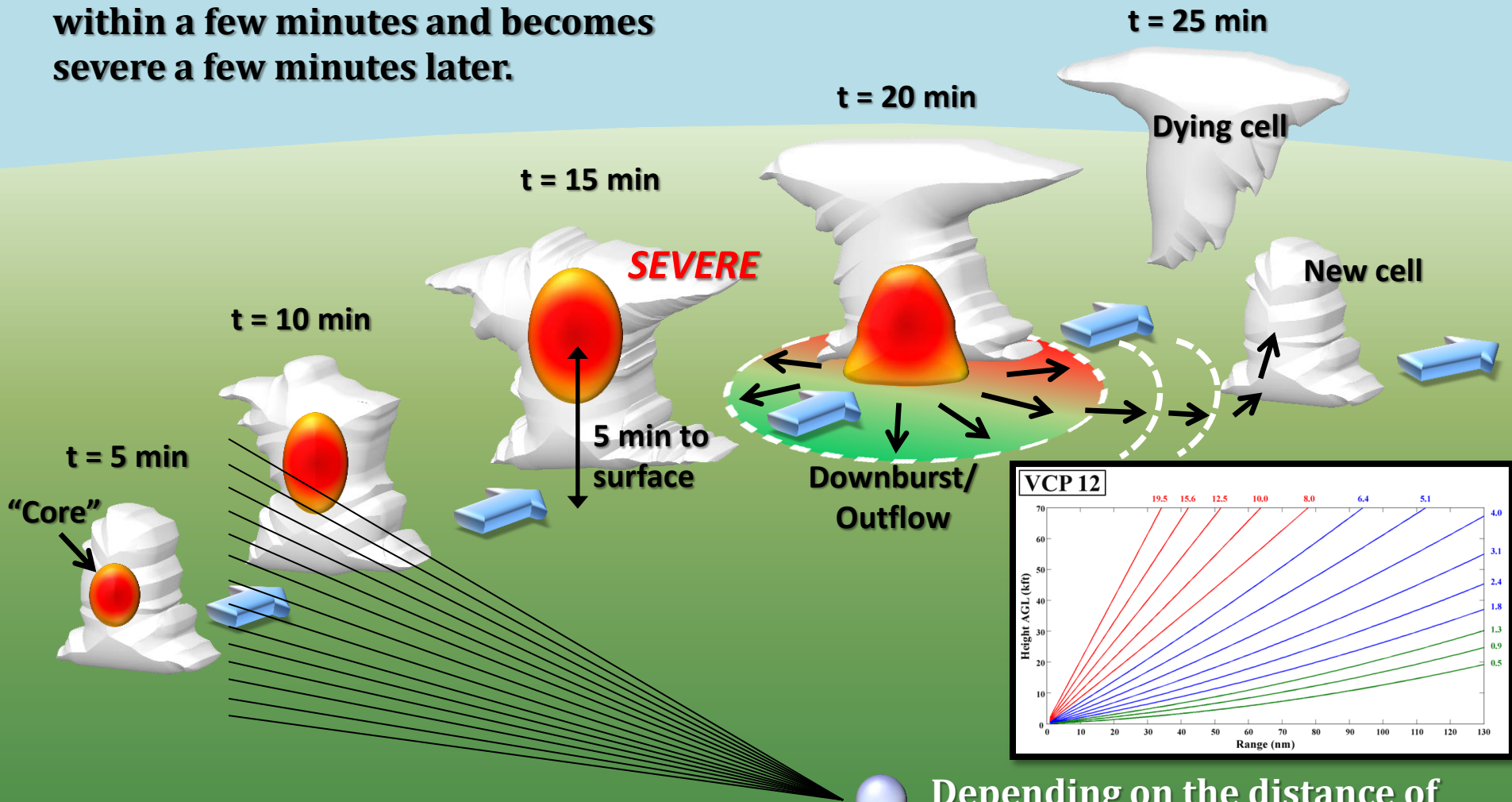
5-6 mi.

The precip begins to “separate” from the outflow/gust front – which is basically outrunning the storm(s). At some point, friction works against the outflow and it dissipates or becomes less intense, but that process takes a while.



Typical thunderstorm lifecycle ...in terms of radar

A thunderstorm cell develops a core within a few minutes and becomes severe a few minutes later.

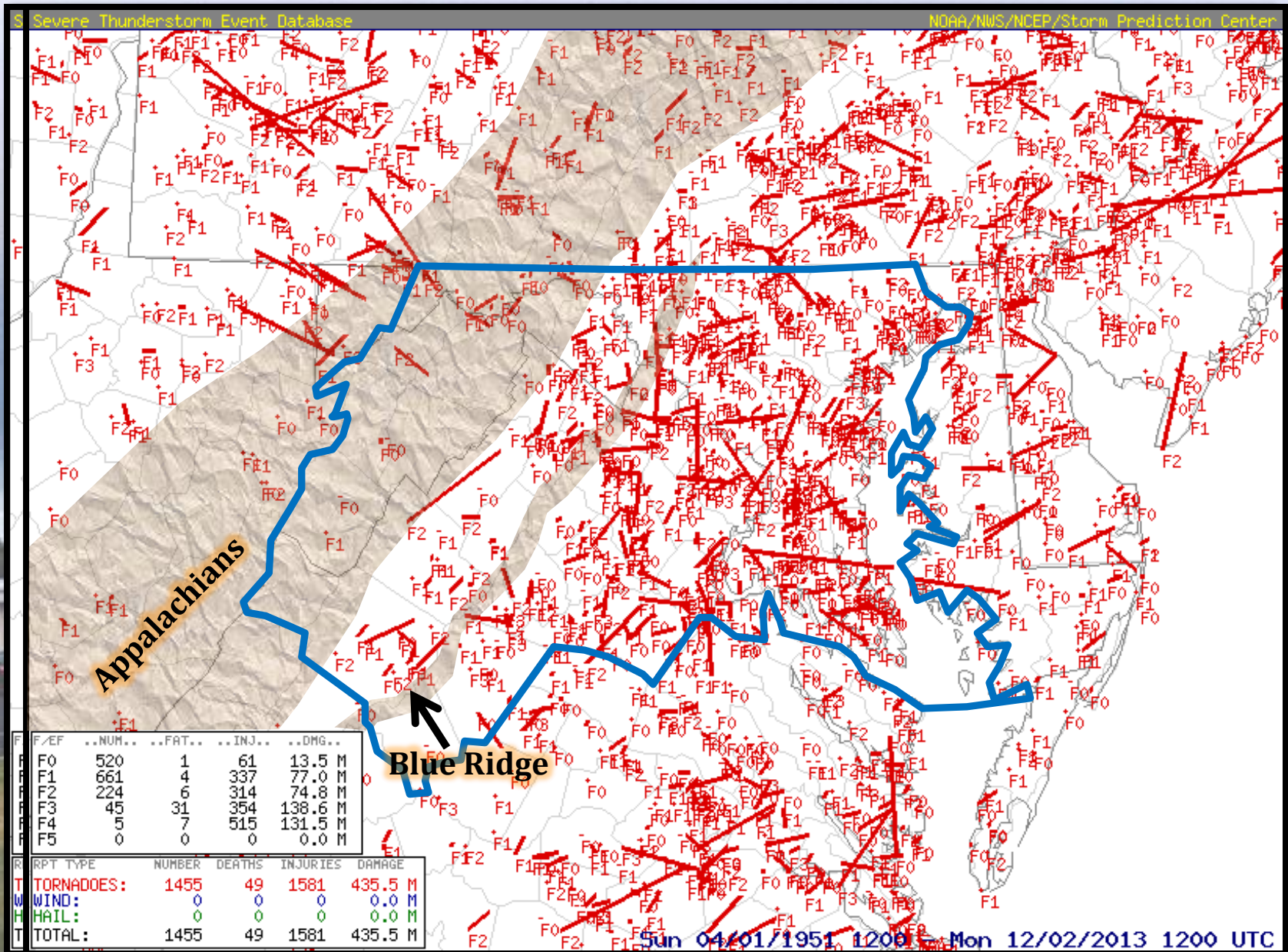


This example represents typical "pulse" storms w/ little wind shear. "Linear" storms - squall lines have typically much longer lead time since they are self-sustaining and can last hundreds of miles

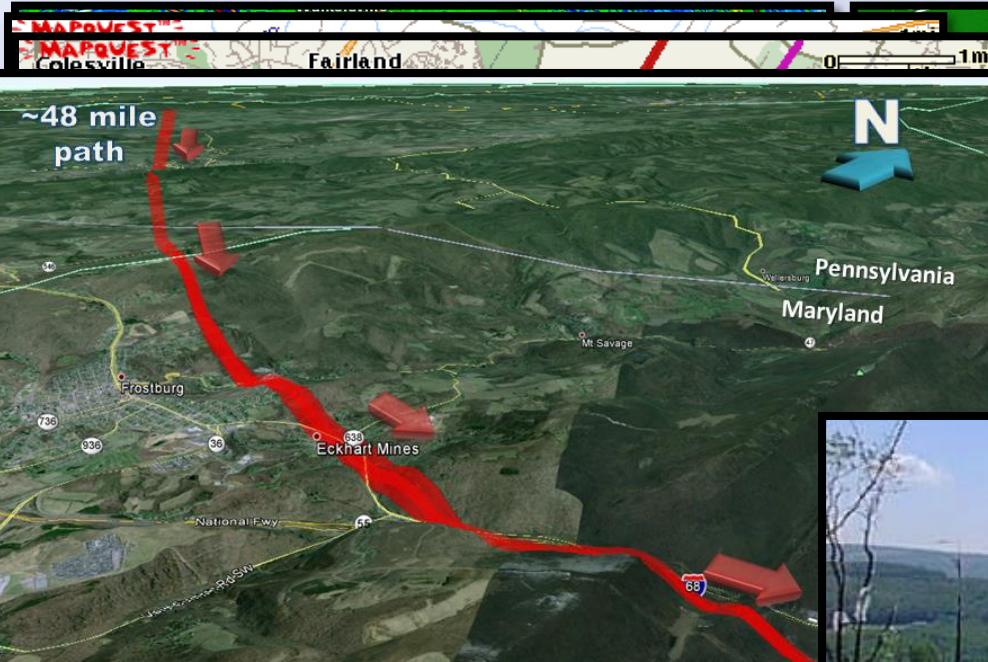


Depending on the distance of storms, VCP 12 can run full volumes between 3.5 and 4.5 min.

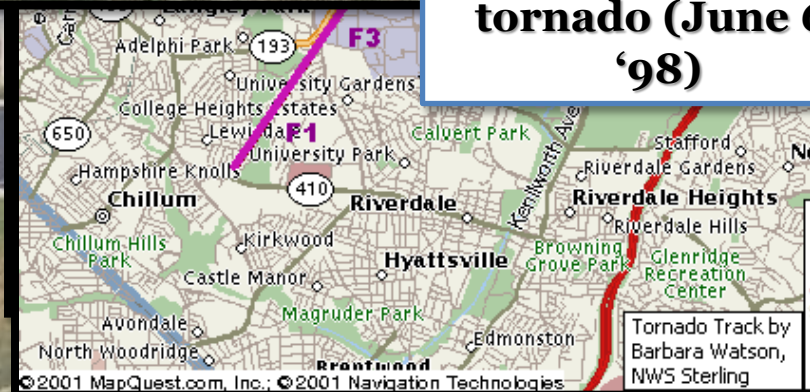
What's our tornado history?



Some of the more high-impact severe events...



**Frostburg, MD F4
tornado (June 6,
'98)**



**Deadly Petersburg,
VA F4 tornado
(Aug 6, '93)**

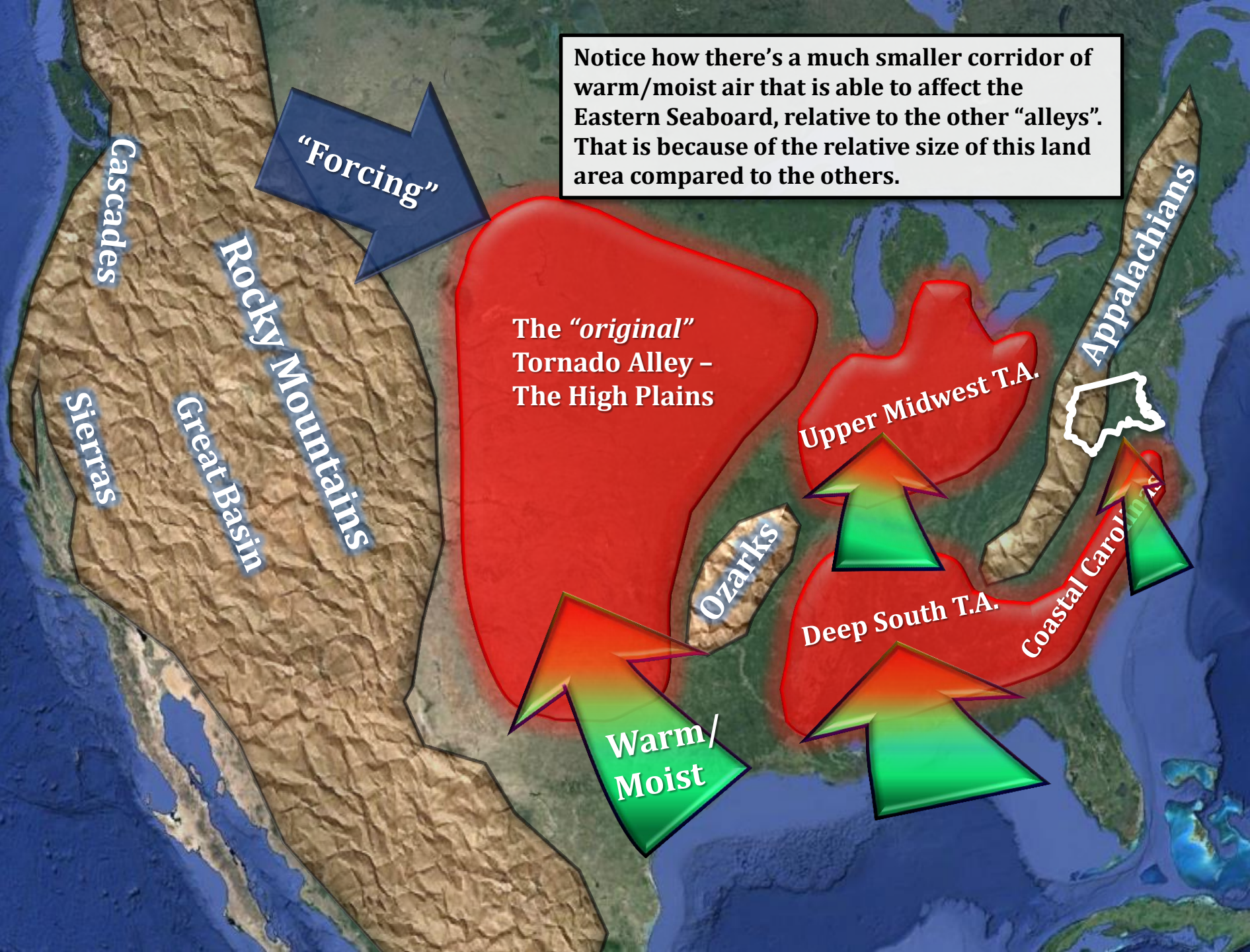


Tornado Track by
Barbara Watson,
NWS Sterling

TOTAL: 3 3 129 131.5 M

Sun 01/01/1950 1200 - Sun 01/02/2011 1200 UTC

Notice how there's a much smaller corridor of warm/moist air that is able to affect the Eastern Seaboard, relative to the other "alleys". That is because of the relative size of this land area compared to the others.



"Forcing"

The "original"
Tornado Alley -
The High Plains

Upper Midwest T.A.

Deep South T.A.

Coastal Carolina T.A.

Appalachians

Ozarks

Warm/
Moist

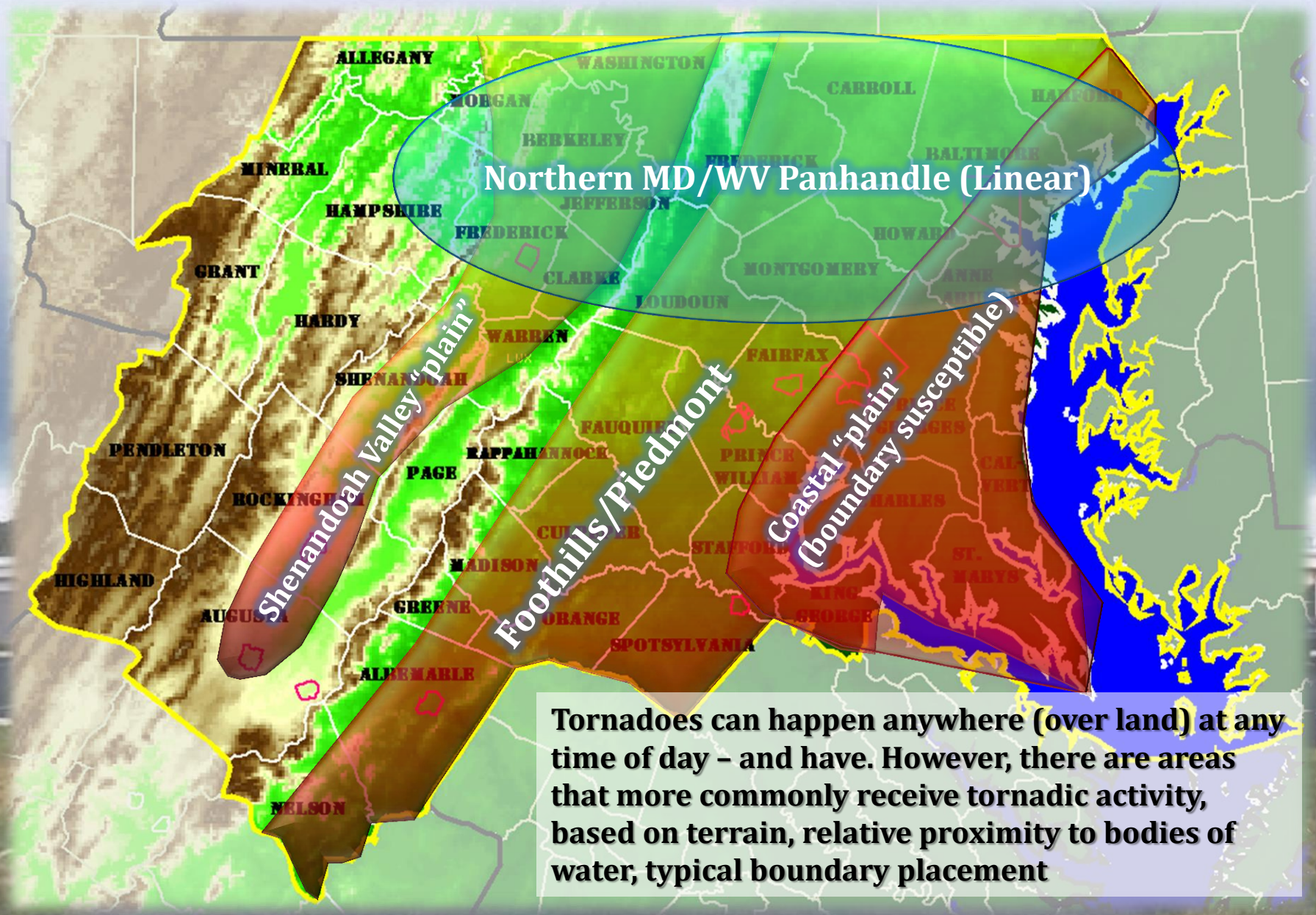
Rocky Mountains



Great Basin

Sierras

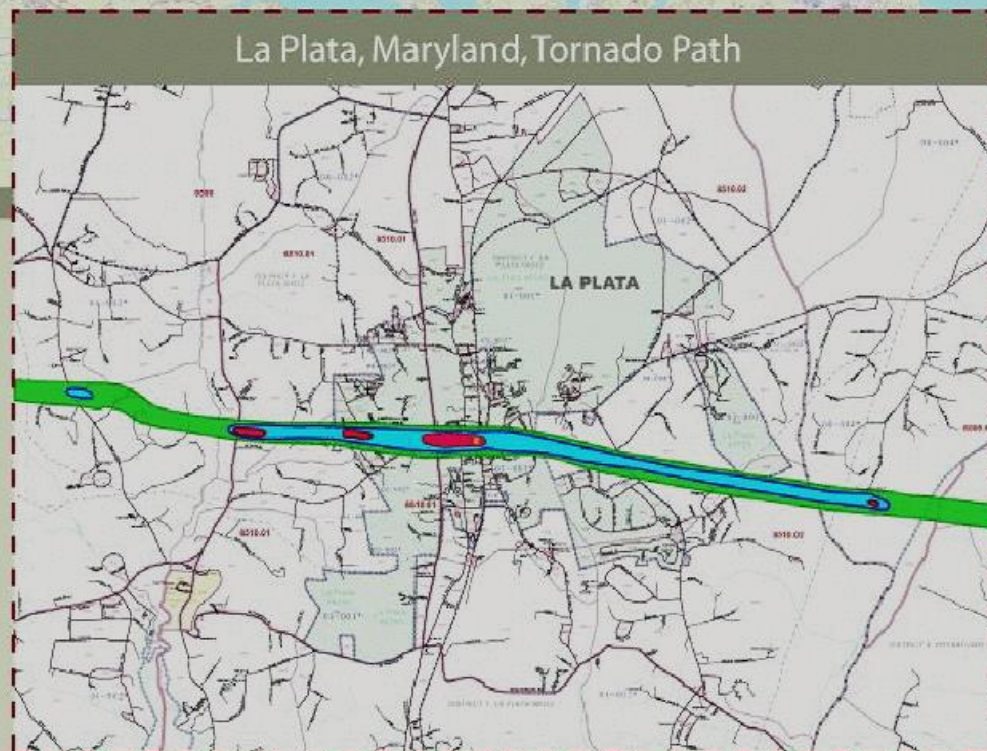
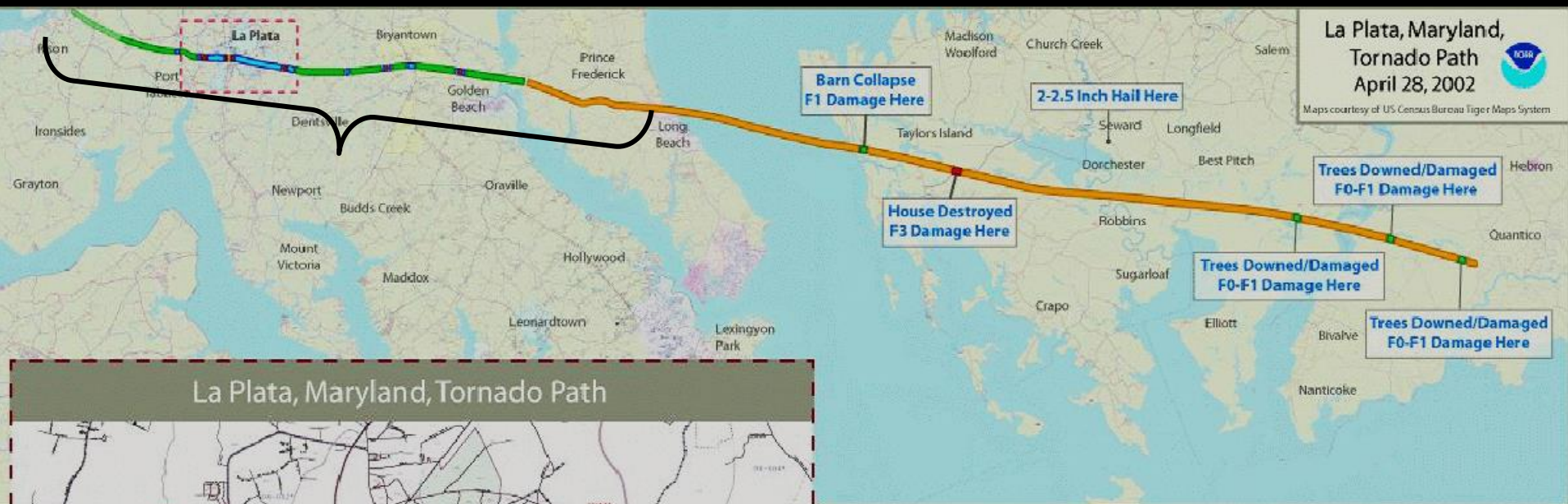
Cascades

Area tornado hotspots



EF Rating	Wind Speeds	Expected Damage	
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.	 
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.	 
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.	 
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.	 
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.	 
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.	 



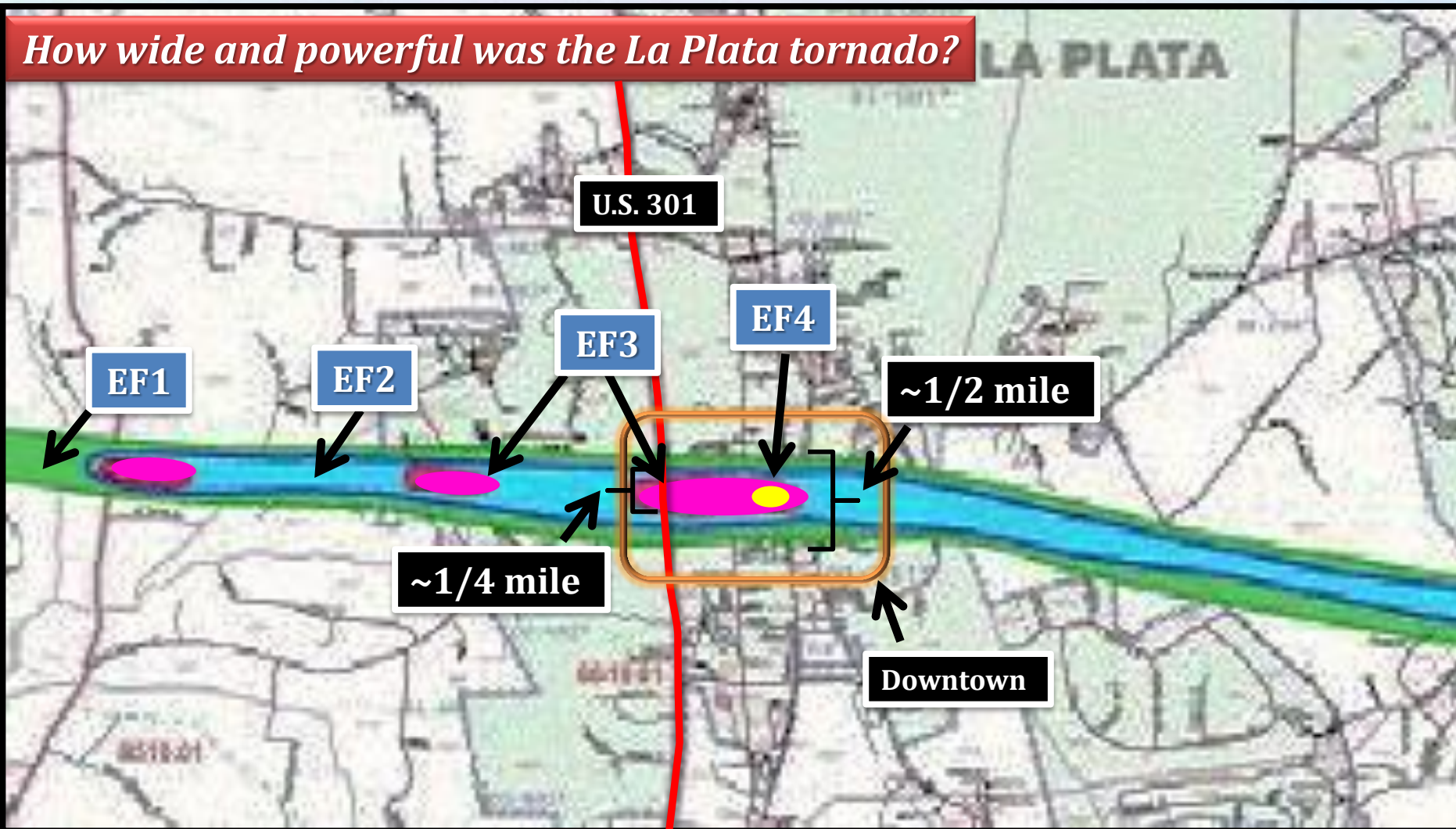


Enlarged view of La Plata, Maryland, where the tornado reached its peak intensity as an F4 tornado.

Tornado Intensity Scale

- F0 Gale tornado**
(40-72 mph)
- F1 Moderate Tornado**
(73-112 mph)
- F2 Significant Tornado**
(113-157 mph)
- F3 Severe Tornado**
(158-206 mph)
- F4 Devastating Tornado**
(207-260 mph)

How wide and powerful was the La Plata tornado?

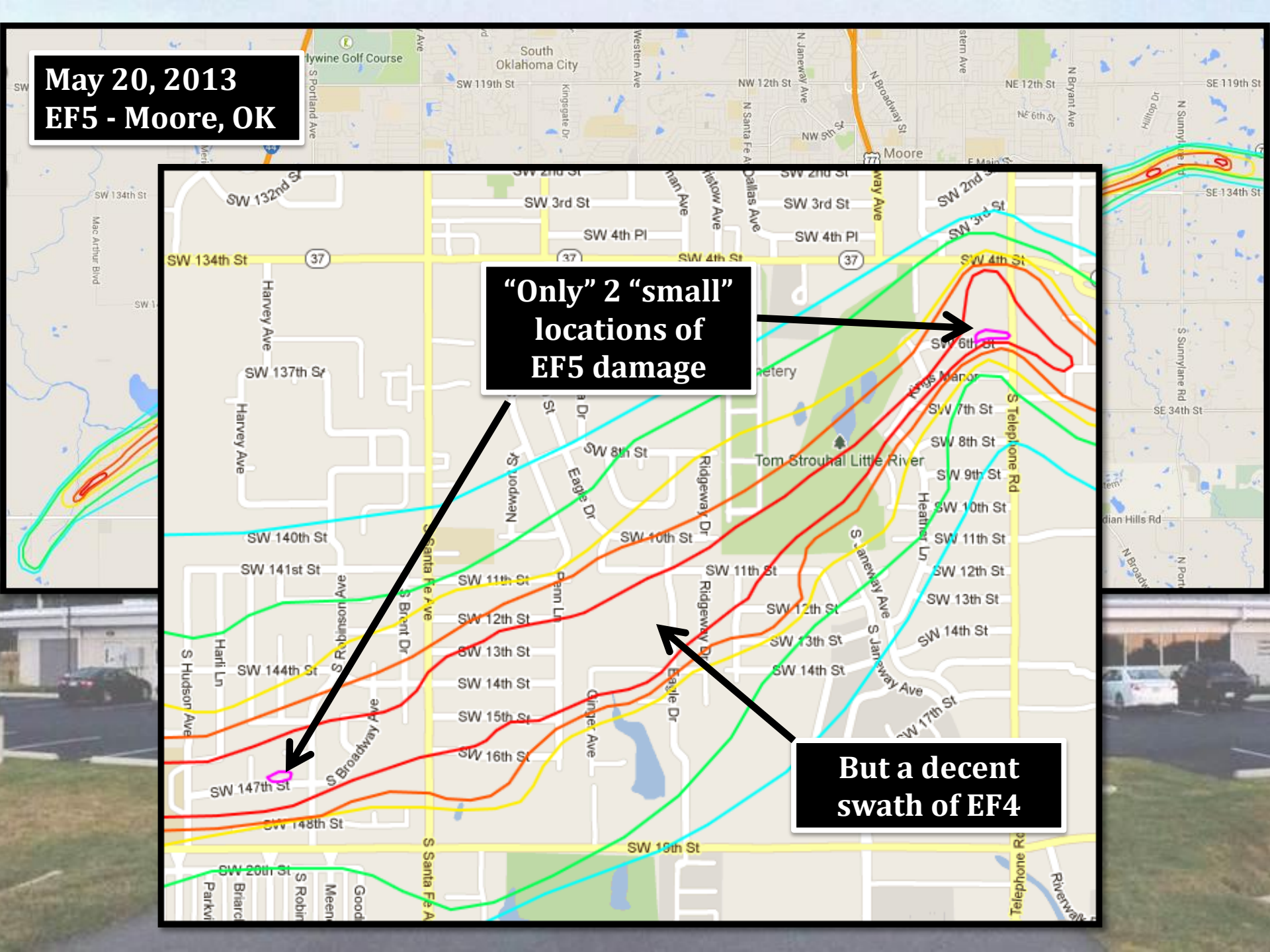


Let's transpose this (slightly stronger/wider) onto a more urbanized area...

May 20, 2013
EF5 - Moore, OK

"Only" 2 "small"
locations of
EF5 damage

But a decent
swath of EF4



5
5:28 pm EDT

BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE BALTIMORE MD
530 PM EDT FRI JUN 8 20XX

THE NATIONAL WEATHER SERVICE

* TORNADO WARNING FOR...
THE DISTRICT OF COLUMBIA
NORTHERN FAIRFAX COUNTY
CITY OF FALLS CHURCH
ARLINGTON COUNTY IN NORTH
MONTGOMERY COUNTY IN CENTRAL

* UNTIL 615 PM EDT...

* AT 528 PM EDT...A SEVERE
WAS 2 MILES SOUTHWEST OF
SOUTHEAST AT 30 MPH.

* LOCATIONS IMPACTED INCLUDE
HERNDON...
RESTON...
GREAT FALLS...
WOLF TRAP...
TYSONS CORNER...
THE AMERICAN LEGION BARRACKS
MCLEAN...
FALLS CHURCH...

TAKE COVER NOW. MOVE TO A
STURDY BUILDING AND AVOID
VEHICLE...MOVE TO THE GROUND
FROM FLYING DEBRIS.

MOTORISTS SHOULD NOT TAKE
RESORT...EITHER PARK AND
AND LAY FLAT IN A LOW SHELTER

LAT...LON 3884 7867 3895 7823
3931 7817 3944 7808 3972 7777 3952 7778
3914 7784 3882 7820
TIME...MOT...LOC 2159Z 270DEG 26KT 3972 7777 3952 7778
3926 7786 3894 7805

\$\$

GMS

BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE BALTIMORE MD
600 PM EDT FRI JUN 8 20XX
...TORNADO EMERGENCY FOR PORTIONS OF CENTRAL MONTGOMERY COUNTY AND ANNE ARUNDEL COUNTY...

THE NATIONAL WEATHER SERVICE

* TORNADO WARNING FOR...
THE DISTRICT OF COLUMBIA
EXTREME EASTERN FAIRFAX COUNTY
CITY OF FALLS CHURCH IN NORTH
ARLINGTON COUNTY IN NORTH
MONTGOMERY COUNTY IN CENTRAL

* UNTIL 645 PM EDT...

* THE NATIONAL WEATHER SERVICE
DANGEROUS TORNADO NEAR DOWNTOWN
FT MEYER. DOPPLER RADAR SHOWED THIS TORNADO MOVING EAST AT 30 MPH.

THIS IS A TORNADO EMERGENCY FOR THE CITY OF LARGO AND SURROUNDING AREAS. TAKE COVER NOW.

* LOCATIONS IMPACTED INCLUDE
ARLINGTON...
ARLINGTON NATIONAL CEMETERY
FT MEYER...
ADAMS MORGAN...
DOWNTOWN WASHINGTON...
US CAPITOL...
NATIONALS PARK...
RFK STADIUM...

PRECAUTIONARY/PREPAREDNESS ACTIONS...

TO REPEAT...A LARGE...EXTREMELY DANGEROUS...AND POTENTIALLY DEADLY TORNADO IS ON THE GROUND. TO PROTECT YOUR LIFE...TAKE COVER NOW. MOVE TO AN INTERIOR ROOM ON THE LOWEST FLOOR OF A STURDY BUILDING. AVOID WINDOWS. IF IN A MOBILE HOME...A VEHICLE OR OUTDOORS...MOVE TO THE CLOSEST SUBSTANTIAL SHELTER AND PROTECT YOURSELF FROM FLYING DEBRIS.

LAT...LON 3884 7867 3895 7823
3931 7817 3944 7808 3972 7777 3952 7778
3914 7784 3882 7820
TIME...MOT...LOC 2159Z 270DEG 26KT 3972 7777 3952 7778
3926 7786 3894 7805

\$\$

GMS

BULLETIN - EAS ACTIVATION REQUESTED
TORNADO WARNING
NATIONAL WEATHER SERVICE BALTIMORE MD/WASHINGTON DC
630 PM EDT FRI JUN 8 20XX

...TORNADO EMERGENCY FOR PORTIONS OF CENTRAL MONTGOMERY COUNTY AND ANNE ARUNDEL COUNTY...

THE NATIONAL WEATHER SERVICE IN STERLING VIRGINIA HAS ISSUED A

* TORNADO WARNING FOR...
MONTGOMERY COUNTY IN CENTRAL MARYLAND...
CENTRAL ANNE ARUNDEL COUNTY IN CENTRAL MARYLAND...

* UNTIL 715 PM EDT...

* THE NATIONAL WEATHER SERVICE WAS TRACKING A LARGE AND EXTREMELY DANGEROUS TORNADO 3 MILES SOUTHEAST OF CAPITOL HEIGHTS...OR 2 MILES SOUTHWEST OF LARGO. DOPPLER RADAR SHOWED THIS TORNADO MOVING EAST AT 30 MPH.

THIS IS A TORNADO EMERGENCY FOR THE CITY OF LARGO AND SURROUNDING AREAS. TAKE COVER NOW.

* LOCATIONS IMPACTED INCLUDE
KETTERING...
LARGO...
DISTRICT HEIGHTS...
FORESTVILLE...
BOWIE...
DAVIDSONVILLE...

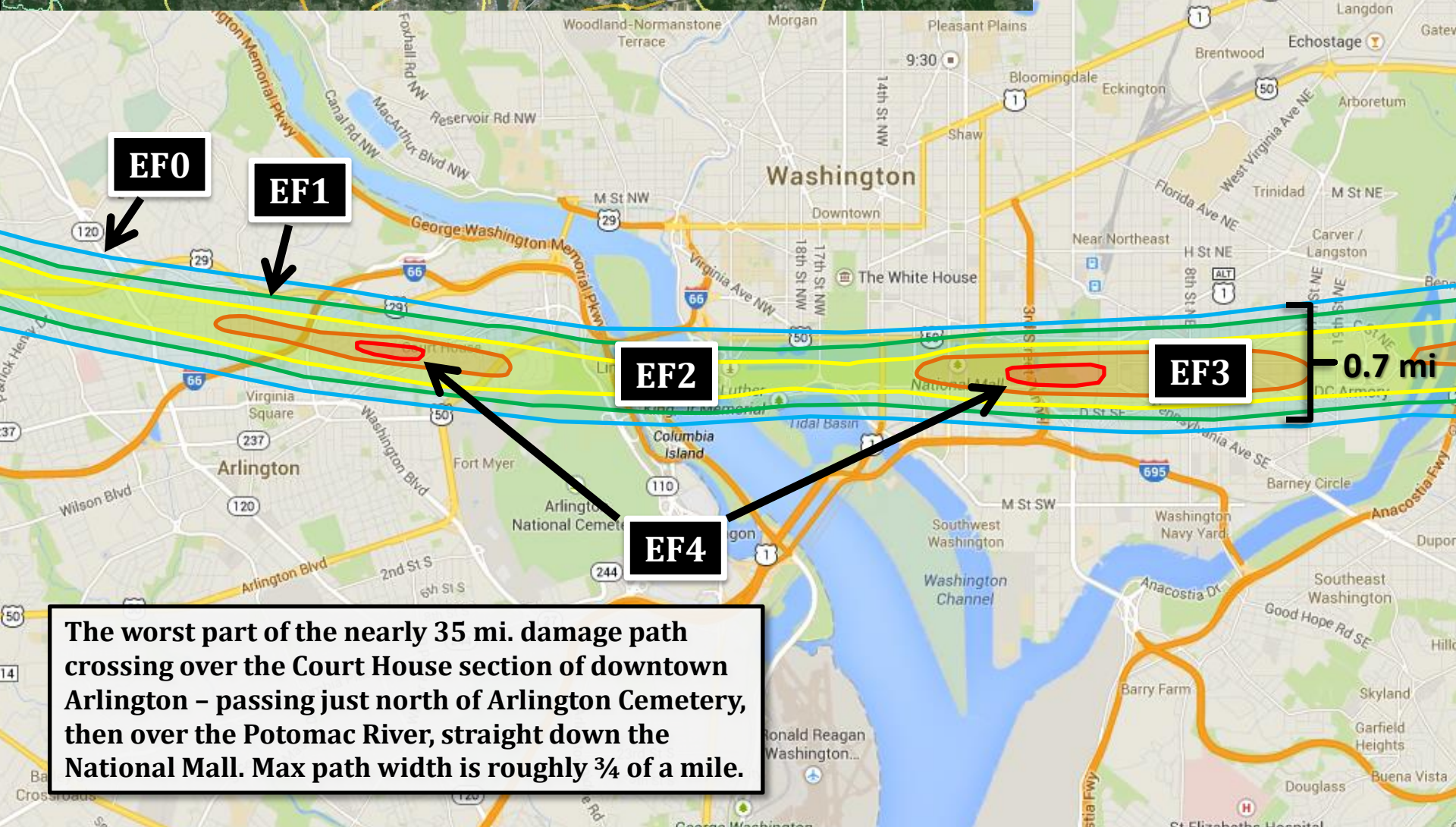
PRECAUTIONARY/PREPAREDNESS ACTIONS...

TO REPEAT...A LARGE...EXTREMELY DANGEROUS...AND POTENTIALLY DEADLY TORNADO IS ON THE GROUND. TO PROTECT YOUR LIFE...TAKE COVER NOW. MOVE TO AN INTERIOR ROOM ON THE LOWEST FLOOR OF A STURDY BUILDING. AVOID WINDOWS. IF IN A MOBILE HOME...A VEHICLE OR OUTDOORS...MOVE TO THE CLOSEST SUBSTANTIAL SHELTER AND PROTECT YOURSELF FROM FLYING DEBRIS.

LAT...LON 3884 7867 3895 7855 3904 7833 3913 7823
3931 7817 3944 7808 3971 7795 3972 7752
3914 7784 3882 7820
TIME...MOT...LOC 2159Z 280DEG 26KT 3972 7777 3952 7778
3926 7786 3894 7805

\$\$

GMS

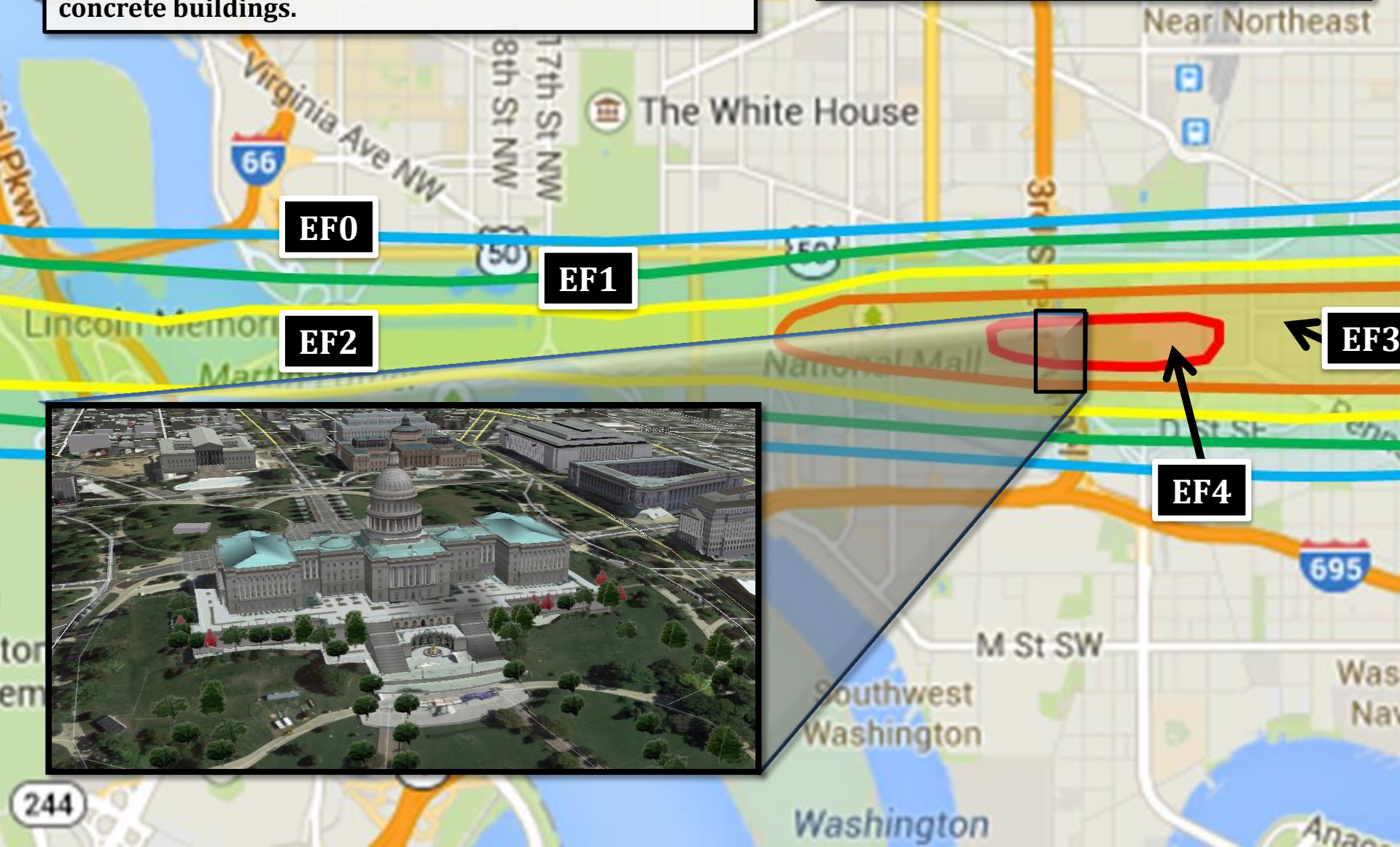


The worst part of the nearly 35 mi. damage path crossing over the Court House section of downtown Arlington – passing just north of Arlington Cemetery, then over the Potomac River, straight down the National Mall. Max path width is roughly $\frac{3}{4}$ of a mile.

Zooming-in even further to the heart of downtown D.C.

A solid swath of EF2-type damage, though the damage points would be subjective with part of the river, rows of trees and only a few structures, surrounded by concrete buildings.

Unfortunately, the “post-river” flat land expanse gives the tornado enough room after crossing the Potomac to intensify directly over The U.S. Capitol & surrounding buildings.



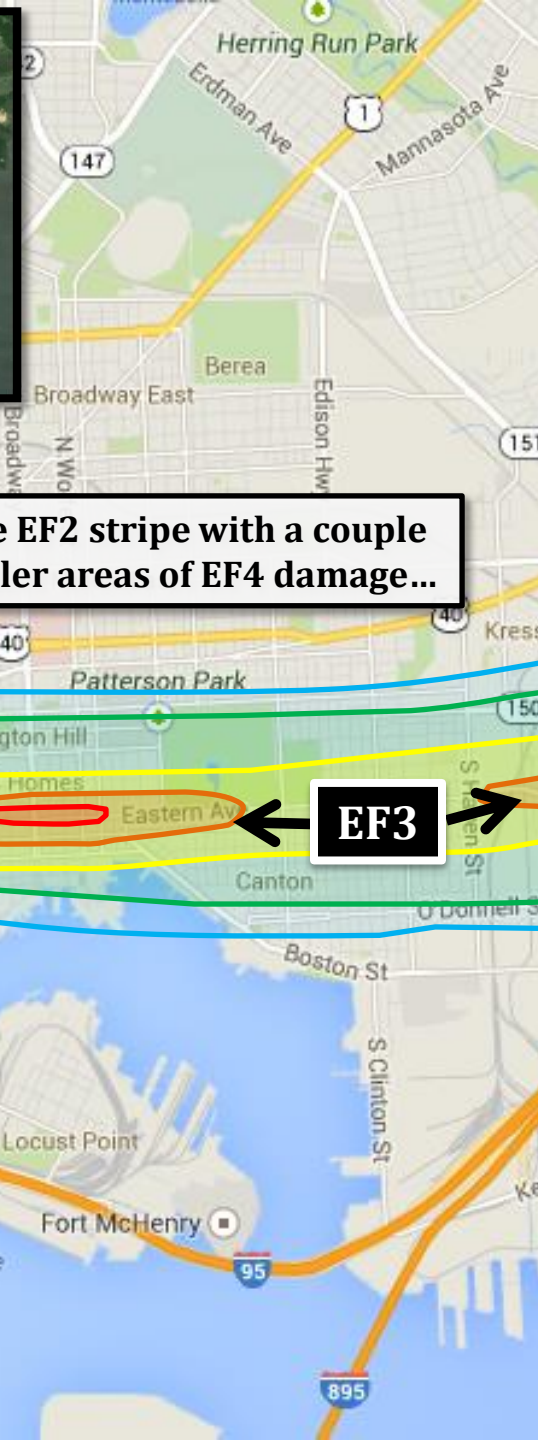
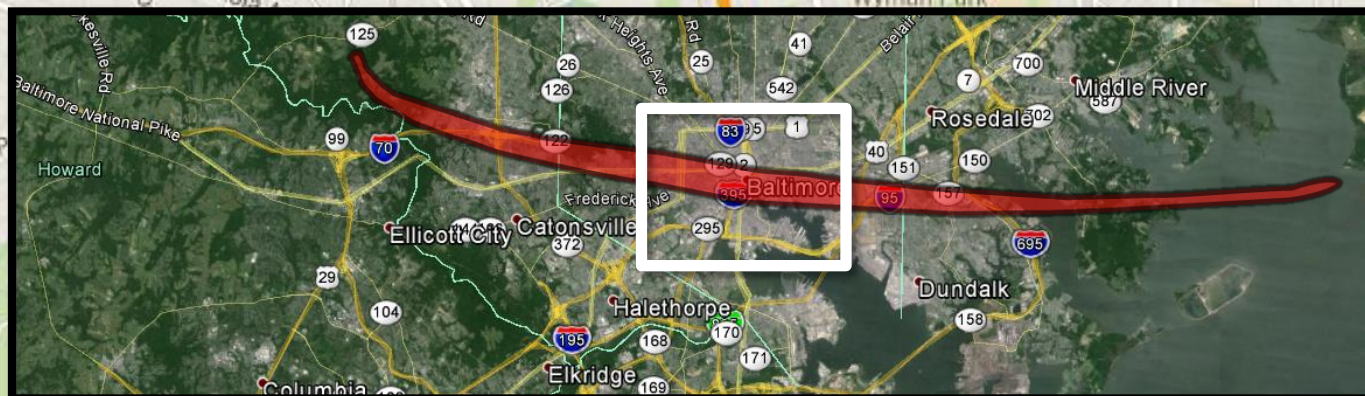
EF0

EF1

EF2

EF3

EF4



A steady 0.3-0.4 mi. wide EF2 stripe with a couple of pockets of EF3 & smaller areas of EF4 damage...

EF0

EF1

EF2

EF3

EF4

Not to leave anyone out and actually, Baltimore has just as good a chance - if not better - of having a similar scenario.

Imagine this same storm scraping a 35 mi. path, with the worst going through downtown Baltimore.

Post-Event Assessment

No Warning System in-place

Deaths: ?????
Injuries: ?????

Effective Warning and Dissemination

Deaths: ?????
Injuries: ?????

What does this mean to you?

How will you prepare?

June 29-30, 2012 Derecho (entire path) ~\$3 billion

* Tree and power line damage, trees on homes, tree removal, etc.

May 20, 2013 - Moore, OK EF-5:

24 deaths; nearly 400 injuries

14 minutes from initial warning to touchdown
39 minutes on ground
17 mile path

Baltimore Area Damage Estimates: \$1-2 billion

* Downtown Baltimore - millions on Inner Harbor commerce, buildings, shipping infrastructure (just missed stadiums, but what if it didn't)
* Suburban Areas - similar to Moore, OK but more structures and road networks affected

May 20, 2013 - Moore, OK EF-5: \$2-3 billion

* Mostly homes, small commercial buildings, a few schools, and other suburban dwellings



Takeaways

Severe Thunderstorm Warnings cannot be taken for granted

- Not all T-storms are created equally but a severe one is enough to damage/injure/kill – so can “near-severe” (lightning, strong winds)
- Most deaths (in this area) from falling trees/limbs – severe winds
 - * M.A. is covered in trees – old ones too (as 2012 Derecho showed)
- Winds (even severe strength) can be well out ahead of precip – stay alert!

Tornadoes

- We get them, plenty of them – strong ones are rare but not unprecedented
- EF5 strength? High unlikely but possible.
 - * We don't need an EF5 or a large wedge for it to be devastating.
- Tornadoes (even the worst ones) can happen any time of the year

Damage Paths

- VERY variable. House to house, tree to tree, different effects along a path
 - * Classification for a tornado is for the worst damage but it may be only a tiny portion of the path.

PRECAUTIONARY/PREPAREDNESS ACTIONS...

THIS IS A DANGEROUS STORM. IF YOU ARE IN ITS PATH...PREPARE IMMEDIATELY FOR DAMAGING WIND GUSTS AND FREQUENT CLOUD TO GROUND LIGHTNING. MOVE INDOORS TO A STURDY BUILDING AND STAY AWAY FROM WINDOWS.